

DEFICIENCIES OF MAJOR NUTRIENT ELEMENTS IN *PROTEA CYNAROIDES* LINN., GROWN IN SAND CULTURE.

II. EFFECT ON GROWTH AND CHEMICAL COMPOSITION

J. VAN STADEN

(Bews Botanical Laboratories, University of Natal, Pietermaritzburg,
Republic of South Africa)

ABSTRACT

The effects were investigated of deficiencies of the major nutrient elements (N, P, K, Ca, Mg, S, and Fe) on the growth and chemical composition of *Protea cynaroides* grown in sand culture.

Only deficiencies in the rooting medium of K, N, and Ca had appreciable effects on growth and a deficiency of iron alone influenced the chemical composition of the plants.

INTRODUCTION

In a previous paper (van Staden, 1967) mineral deficiency symptoms in *P. cynaroides* were described.

Except for a short report by Schütte (1960) on trace element deficiencies in the Cape vegetation, no information is available on the growth and chemical composition of the South African Proteaceae. Another recent study of mineral nutrition in the Proteaceae is that of Moore and Keraitis (1966), in which was reported deficiency symptoms in *Greyvillea robusta*, in Australia.

In the present paper, the effect of the major nutrient elements on the growth and chemical composition of *P. cynaroides* is described.

MATERIAL AND METHODS

Plants (three per treatment) of *Protea cynaroides* Linn., were grown in 24 clay pots for 41 weeks in a greenhouse maintained between 8° and 30°C, as previously described (van Staden, 1967). At the end of this time, each plant was carefully removed from the sand and the roots washed with deionised water. Each was then divided into stems and roots (at the cotyledonary node)

and leaves. Stem length was measured from the growing point to the cotyledonary node. Dry weights of stems, leaves and roots were determined after drying at 105°C for 48 hours.

The leaves and stems were analyzed for total nitrogen, potassium, magnesium and iron according to the methods described by Humphries (1956). Calcium was determined by the method of Wolf and Ichisaka (1947) and phosphorus by the method of Jackson (1958). All colorimetric determinations (P, Ca, and Fe) were made with a Model 900·3 Klett-Summerson Photoelectric colorimeter. For the determination of potassium and magnesium a Zeiss PM Q II Flame photometer was employed.

RESULTS AND DISCUSSION

Effect on growth: The effects of deficiencies of the various nutrient elements on the yield of *P. cynaroides* are expressed in Table 1.

The results of this experiment indicate that, with the exception of potassium, calcium and in two instances nitrogen, deficiencies of the major nutrient elements had relatively little effect upon the growth of *P. cynaroides*. Deficiencies of potassium and calcium, however, resulted in a diminution of almost all the aspects of growth measured. A nitrogen deficiency only affected the dry weight yield of leaf and root. The rest of the treatments (P, Mg, S, and Fe) had no significant effects on any characters measured. The deficiencies were obtained within 10 weeks after the plants had previously been grown with complete nutrient solutions (van Staden, 1967). Thus it might be expected that deficiencies of potassium and calcium will have a pronounced effect upon this species in nature, as well as in cultivation. It is further of interest that the results of the deficiencies are similar to those reported in other plants (Wallace, 1961; Lockard and Asomaning, 1964; Nichols, 1965; Moore and Keraitis, 1966). This indicates that *P. cynaroides* is very sensitive and that the slightest

TABLE I

Effect of major nutrient element deficiencies on the number of leaves, stem length, and dry weight of *Protea cynaroides*.

	Treatment								L.S.D.
	Control	-N	-P	-K	-Ca	-Mg	-S	-Fe	
Number of leaves	118	80	116	59	85	88	99	85	49
Stem length (cm)	23·4	8·0	20·5	7·2	7·1	17·1	16·3	16·9	15·7
Dry weight of leaves (g)	10·7	5·4	8·8	4·2	3·8	9·0	8·5	8·5	5·2
Dry weight of stems and leaves (g)	12·0	6·0	10·1	4·6	4·3	10·0	9·8	9·4	7·1
Dry weight of roots (g)	1·4	0·7	1·1	0·5	0·4	0·9	0·8	0·7	0·7

form of malnutrition will have a marked effect upon its growth.

Effect on chemical composition: The effects of mineral deficiencies on the chemical composition of *P. cynaroides* are given in Table 2.

As could be expected, due to the fact that the plants were grown with a complete nutrient solution for 31 weeks, deficiencies of the major nutrient elements had hardly any effect on the chemical composition of *P. cynaroides*. It is, however, of significance that the iron content of the plants decreased significantly with nitrogen, potassium, calcium and iron deficiencies in the rooting medium. With each of these deficiencies severe chlorosis and necrosis of leaves was observed. Wallace and Hewitt (1946) pointed out that deficiencies of potassium, phosphorus or calcium are possible causes of apparent iron deficiency in plants. It would seem as if mineral interrelationships possibly played a role in *P. cynaroides* but this has not yet been substantiated.

TABLE II
Effect of major nutrient element deficiencies on the chemical composition of
Protea cynaroides.

mg/g dry wt.	Treatment								L.S.D.
	Control	-N	-P	-K	-Ca	-Mg	-S	-Fe	
Phosphorus	2.65	3.14	1.37	6.01	8.93	2.44	4.89	1.75	4.41
Potassium	14.8	14.6	13.6	10.2	13.1	15.4	15.0	13.1	5.8
Calcium	4.16	3.72	2.58	1.62	2.62	2.60	2.69	3.64	1.60
Magnesium	2.86	2.86	3.00	2.83	1.77	2.98	3.97	3.53	2.23
Iron	2.67	1.15	1.56	1.14	0.96	2.08	2.96	0.73	1.42
Nitrogen (%)	1.84	1.61	1.76	1.99	1.85	2.12	2.08	1.65	0.86

ACKNOWLEDGEMENTS

This investigation was supported by a grant from the C.S.I.R., for which I am most grateful.

I wish to thank Dr. A. R. A. Noel for his assistance with the preparation of the manuscript.

REFERENCES

- HUMPHRIES, E. C. (1956): Mineral components and ash analysis. In: K. Paech and M. V. Tracey (Ed). *Modern methods of plant analysis*. Vol. I: 468-502. Berlin: Springer-Verlag.
- JACKSON, M. L. (1958): *Soil chemical analysis*. New Jersey. Prentice-Hall.
- LOCKARD, R. G. AND ASOMANING, E. J. A. (1964): Mineral nutrition of cacao (*Theobroma cacao* L.) I. Deficiency symptoms and nutrient levels in plants grown in sand culture. *Plant and Soil* 21: 142-152.
- MOORE, C. W. E. AND KERATIS, K. (1966): Nutrition of *Grevillea robusta*. *Aust. J. Bot.* 14: 151-163.

- NICHOLS, R. (1964): Studies on the major-element deficiencies of the pigeon pea (*Cajanus cajan*) in sand culture. I. Foliar symptoms of the major-element deficiencies. *Plant and Soil* 21: 377—387.
- SCHÜTTE, K. H. (1960): Trace element deficiencies in Cape vegetation. *J. S. Afr. Bot.* 26: 45—49.
- VAN STADEN, J. (1967): Deficiencies of major nutrient elements in *Protea cynaroides* Linn., grown in sand culture. I. Foliar symptoms of deficiencies. *J. S. Bot.* 33: 59—64.
- WALLACE, T. (1961): *The diagnosis of mineral deficiencies in plants by visual symptoms*. Her Majesty's Stationery Office. London.
- WALLACE, T. AND HEWITT, E. J. (1946): Studies on iron deficiency of crops. I. Problems of iron deficiency and the interrelationships of mineral elements in iron nutrition. *J. Pomol. Hort. Sci.* 22: 133—161.
- WOLF, B. AND ICHISAKA, Y. (1947): Rapid chemical soil and plant tests. *Soil Sci.* 64: 227—244.